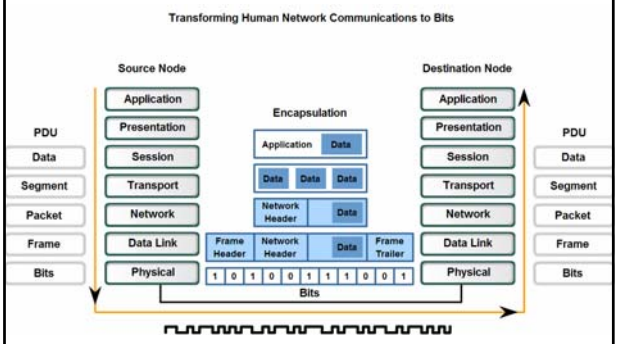
OSI Physical Layer

Network Fundamentals – Chapter 8

Cisco Networking Academy® Mind Wide Open™

Review OSI Layer Services



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Physical Layer Protocols & Services

- The purpose of the Physical layer is to create the electrical, optical, or microwave signal that represents the bits in each frame.
- The three fundamental functions are:
- Data encoding
  - method of converting a stream of data bits into predefined 'codes'
- Signaling
  - how bits are represented on the physical media
- The physical components
  - connectors and cables

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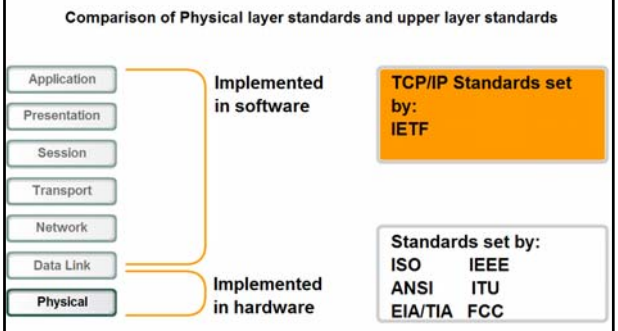
Physical Layer Standards



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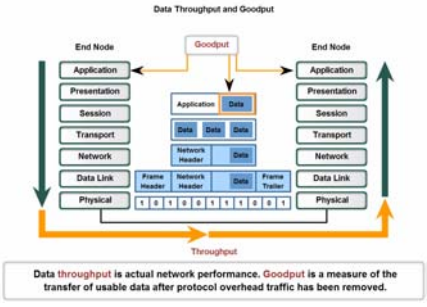
Data Carrying Capacity of a Network

- Digital bandwidth is measured in bits per second
  bps, kbps, Mbps, Gbps, Tbps



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Signaling Methods

- The method of representing the bits is called the signaling method
- The Physical layer standards must define what type of signal represents a "1" and a "0".
- Non Return to Zero (NZR) is the simplest signaling method used
  - Low voltage represents logic 0, high logic 1.
  - Inefficient. Only suitable for slow links.
  - Problems with long runs of individual bit – loss of synchronization.

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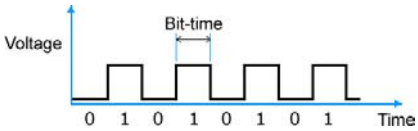
Non Return to Zero (NRZ) Signaling

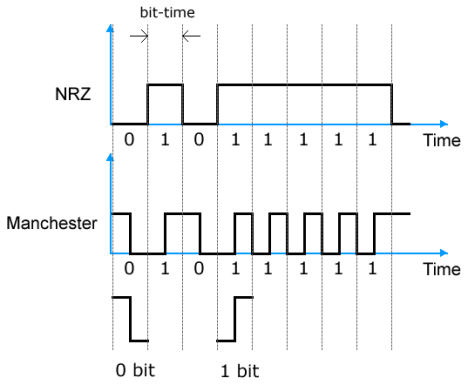


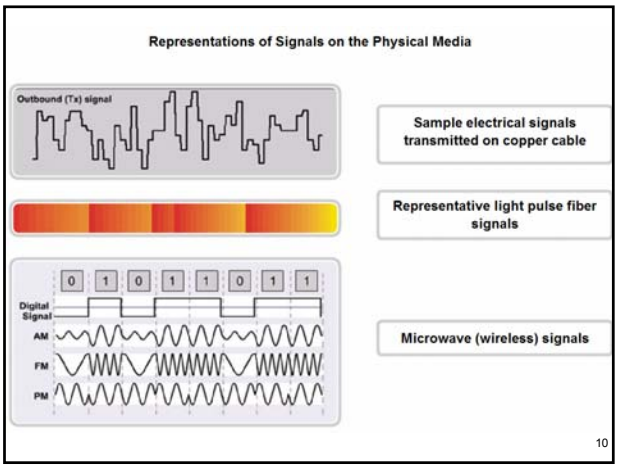
- The Receiver samples the media in the middle of the bit-time
- On LANs, clocks at the Sender and Receiver keep in synch by noting the transitions between high and low voltage
- If a number of consecutive 1's or 0's is transmitted, the clocks may drift out of synch and the Receiver miss-read a bit.

Manchester Encoding

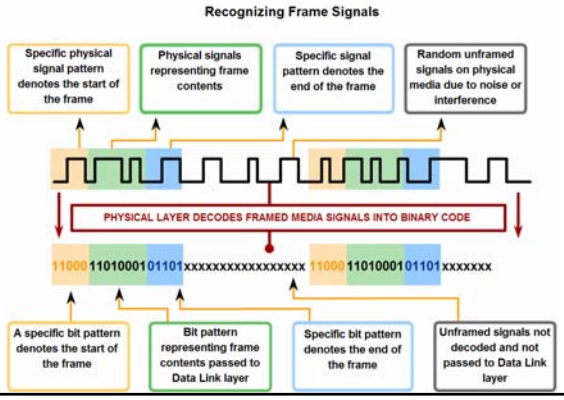
- The signaling method employed by 10BaseT Ethernet (10Mbps)
- A transition from a low voltage to a high voltage represents a bit value of 1.
- A transition from a high voltage to a low voltage represents a bit value of 0.
- Since every bit involves a transition, the clocks can stay in synch.

NRZ vs Manchester Encoding





Encoding



Code Groups

- A code group is a consecutive sequence of code bits (symbol) that are interpreted and mapped as data bit patterns.
- Although using code groups introduces overhead in the form of extra bits to transmit, they improve the robustness of a communications link
- Advantages using code groups include:
  - Reducing bit level error
  - Limiting the effective energy transmitted into the media
  - Helping to distinguish data bits from control bits
- The next slide shows the mapping for the code group 4B/5B. Other encodings are generally more complex

4B data code	5B symbol	Control code	5B symbol
0000	11110	idle	11111
0001	01001	start of stream	11000
0010	10100	start of stream	10001
0011	10101	end of stream	01101
0100	01010	end of stream	00111
0101	01011	transmit error	00111
0110	01110	invalid	00000
0111	01111	invalid	00001
1000	10010	invalid	00010
1001	10011	invalid	00011
1010	10110	invalid	00100
1011	10111	invalid	00101
1100	11010	invalid	00110
1101	11011	invalid	01000
1110	11100	invalid	10000
1111	11101	invalid	11001

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Characteristics & Uses of Network Media

Physical Media - Characteristics

Ethernet Media

	10BASE-T	100BASE-TX	100BASE-FX	1000BASE-CX	1000BASE-T	1000BASE-SX	1000BASE-LX	1000BASE-ZX	100GBASE-ZR
Media	EIA/TIA Category 3, 4, 5 UTP, two pair	EIA/TIA Category 3, 4, 5 UTP, two pair	50/62.5 µm multi mode fiber	STP	EIA/TIA Category 3, 4, 5 UTP, four pair	62.5/50 micron multimode fiber	50/62.5 micron multimode fiber or 9 micron single mode fiber	9µm single mode fiber	9µm single mode fiber
Maximum Segment Length	100m (328 feet)	100m (328 feet)	2 km (6562 ft)	25 m (82 feet)	100 m (328 feet)	Up to 550 m (1,804 ft) depending on fiber used	550 m (MMF)10 km (SMF)	Approx. 70 km	Up to 80 km
Topology	Star	Star	Star	Star	Star	Star	Star	Star	Star
Connector	ISO 8877 (RJ-45)	ISO 8877 (RJ-45)		ISO 8877 (RJ-45)	ISO 8877 (RJ-45)				

Legacy Ethernet

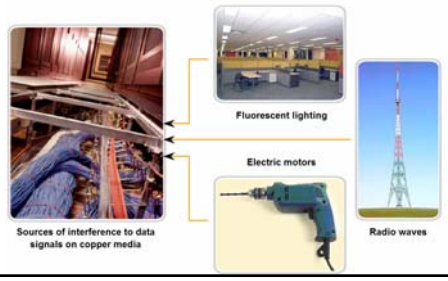
Fast Ethernet

Gigabit Ethernet

Cutting edge

Copper Media – UTP, STP, Coaxial

- Radio waves and electromagnetic devices are potential sources of noise.
- Cable types are designed to minimize signal degradation due to electronic noise.



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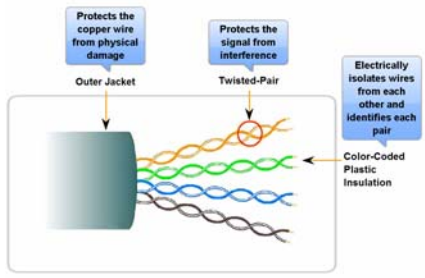
Unshielded Twisted-Pair (UTP)

- This is the most widely used media for LANs
- Relatively easy to install



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UTP Standards

- TIA/EIA-568A stipulates the commercial cabling standards for LAN installations
- IEEE rates UTP cabling, Category 5 (Cat5), Enhanced Category 5 (Cat5e), Category 6 (Cat6).
- Crosstalk is the interference caused by the magnetic field around the adjacent pairs of wires in the cable.
- Twisted pairs of conductors helps prevent crosstalk
- Standard specify the number of twists per meter
- Uses RJ45 jacks and plugs connectors

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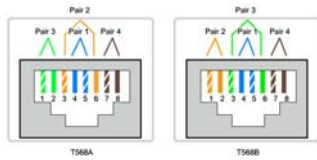
UTP Cable Types

- Ethernet Straight-through

  Connects devices to switches and hubs
- Ethernet Crossover

  Connects PC to PC, switch to switch, PC to router
- Rollover

  Cisco proprietary – For device management



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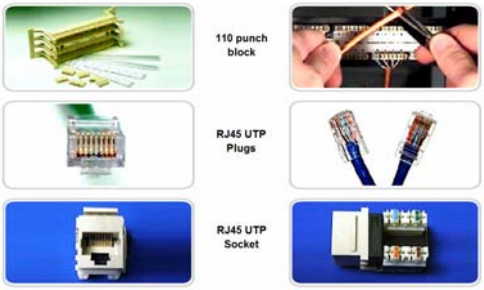
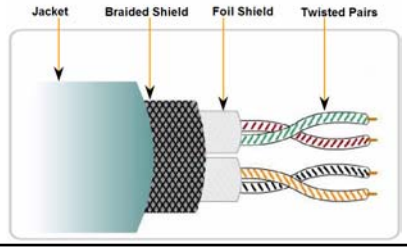
UTP Connectors

- Badly fitted connectors is a serious source of network errors



Shielded Twisted-Pair (STP) Cable

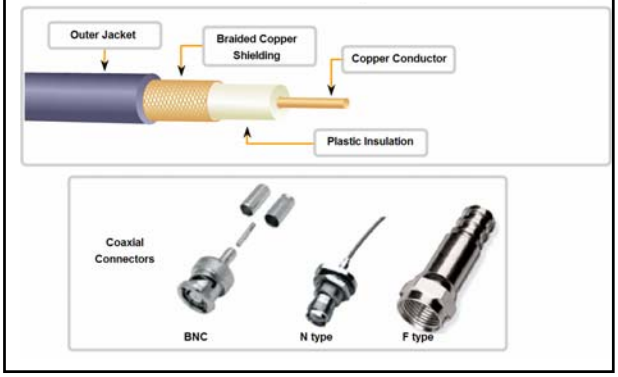
- Used in Token Ring network installations.
- The new 10 GB standard for Ethernet has a provision for the use of STP cabling.
- More expensive than UTP, more difficult to install



Coaxial Cable

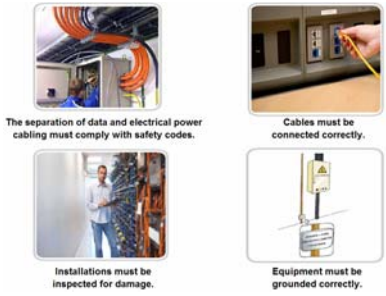
- Coax cables are used to attach antennas to wireless devices.
- Originally used by cable TV networks, now use fibre with coax bringing signal from street into house
- Combined use of fiber and coax is referred to as hybrid fiber coax (HFC).
- Replaced by UTP and fibre in Ethernet installations. Thick Ethernet, thin Ethernet
- BNC connectors

Coaxial Cable



Safety issues when working with copper cabling

- Electrical Hazards – earthing.
- Fire Hazards – cable insulation flammable, produce toxic fumes

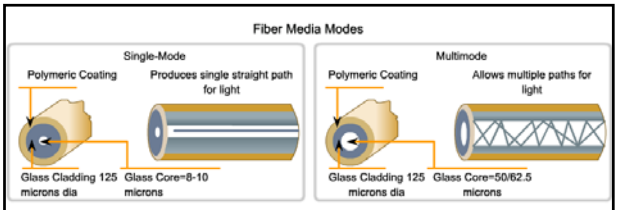


Fiber-optic Cabling

- Uses glass or plastic fibers to guide light impulses from source to destination.
- Capable of very large raw data bandwidth rates.
- Immune to electromagnetic interference and grounding issues.
- Low signal loss, operate at much greater lengths.
- More expensive than copper media
- Different skills and equipment required to terminate and splice the cable infrastructure
- Requires more careful handling than copper media

Two Types of Fiber Cable

- Fiber is primarily used for
  - Backbone cabling for high-traffic point-to-point connections between data distribution facilities
  - Interconnection of buildings in multi-building campuses. (No earthing problems)
- Two types of fiber
  - Multimode 50/125, 62.5/125
    - cheaper, uses LED light source
  - Singlemode 8/125, 10/125
    - uses lasers, operate over longer distances

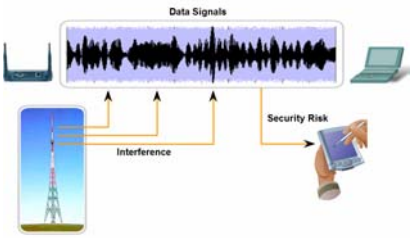


- Small core
- Less dispersion
- Suitable for long distance applications (up to 100 km, 62 mile)
- Uses lasers as light source

- Larger core, 50 microns or more
- More dispersion and hence loss of signal
- Used for long distance applications up to about 2 km
- Uses LEDs as the light source

Wireless Media

- Provides mobility for users
- Susceptible to interference
- Security issues



Wireless Standards

- IEEE 802.11 - Wi-Fi, is a Wireless LAN (WLAN) technology that uses a contention or non-deterministic system with a Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA) media access process.
- IEEE 802.15 - Bluetooth, uses a device pairing process to communicate over distances from 1 to 100 meters.
- IEEE 802.16 - WiMAX (Worldwide Interoperability for Microwave Access), uses a point-to-multipoint topology to provide wireless broadband access.
- Global System for Mobile Communications (GSM) - provide data transfer over mobile cellular telephony networks.
- Satellite communications

Wireless LANs (WLAN, Wi-fi)

- A wireless LAN requires the following network devices:
- Wireless Access Point (AP) - Concentrates the wireless signals from users and connects, usually through a copper cable, to the existing copper-based network infrastructure such as Ethernet.
- Wireless NIC adapters - Provides wireless communication capability to each network host.

WLAN Standards

- IEEE 802.11a - 5 GHz frequency band - up to 54 Mbps.
- IEEE 802.11b - Operates in the 2.4 GHz frequency band and offers speeds of up to 11 Mbps. This is the most commonly used standard
- IEEE 802.11g - Operates in the 2.4 GHz frequency band and offers speeds of up to 54 Mbps.
- IEEE 802.11n standard is currently in draft form. 2.4 Ghz or 5 GHz, data rates 100 Mbps to 210 Mbps with a distance range of up to 70 meters